

AubieSat-1: A Student Designed CubeSat Developed at Auburn University

Richard Chapman, KC4IFB

Jean-Marie Wersinger, KI4YAU

Thor Wilson, KI4TXV

John Klingelhoefter, WB4LNM

Overview

- ***Science Mission***
- ***Overall Design***
- ***Structure***
- ***Electric Power System***
- ***Communications***
- ***Ground station***
- ***Control and Data Handling***
- ***Management and Systems Engineering***



Mission

- ***AubieSat-1 is a communications research amateur satellite***
- ***Explores correlation between spacecraft attitude change (spin) and polarization of received signals at the ground station***
- ***Satellite measures current and voltage over very short time intervals from solar cells on all six faces of the cube***
- ***Rotation in 3-D modeled at ground station and correlated to observed polarization of received signals at the ground station***

Environment

- ***Part of Auburn University Student Space Program (AUSSP), a workforce development program sponsored by NASA through the Alabama Space Grant Consortium and by Auburn University.***
- ***The first step in developing a full fledged student satellite and space research effort at Auburn University***

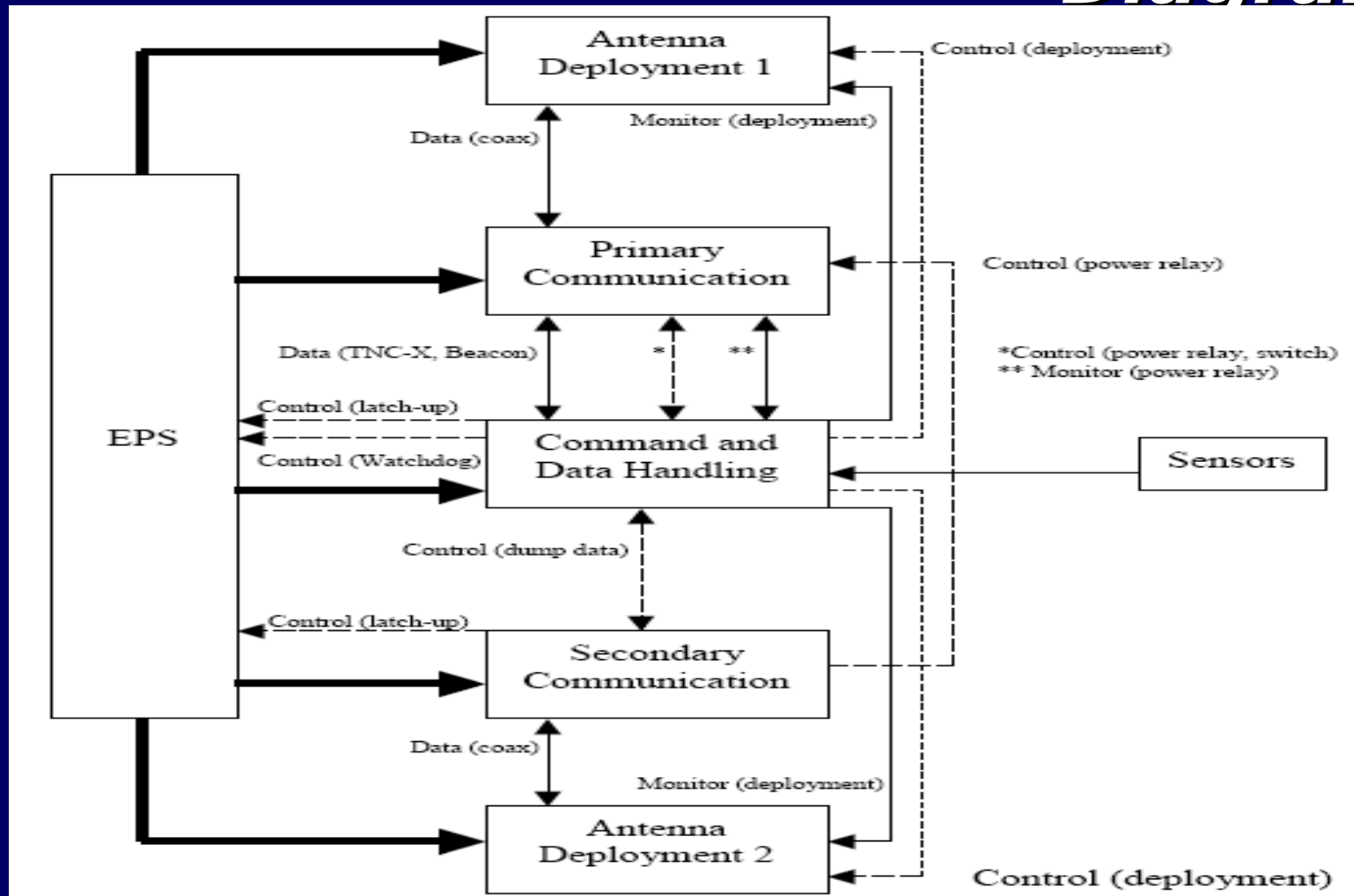
The Auburn University High Altitude Balloon (AHAB) Project



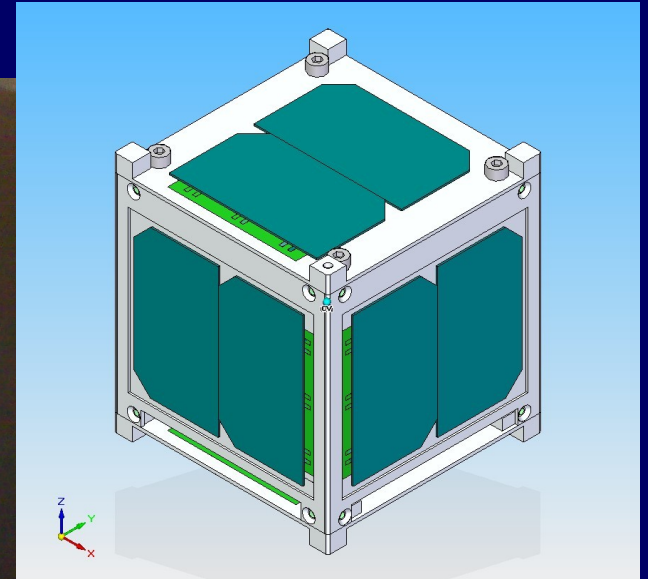
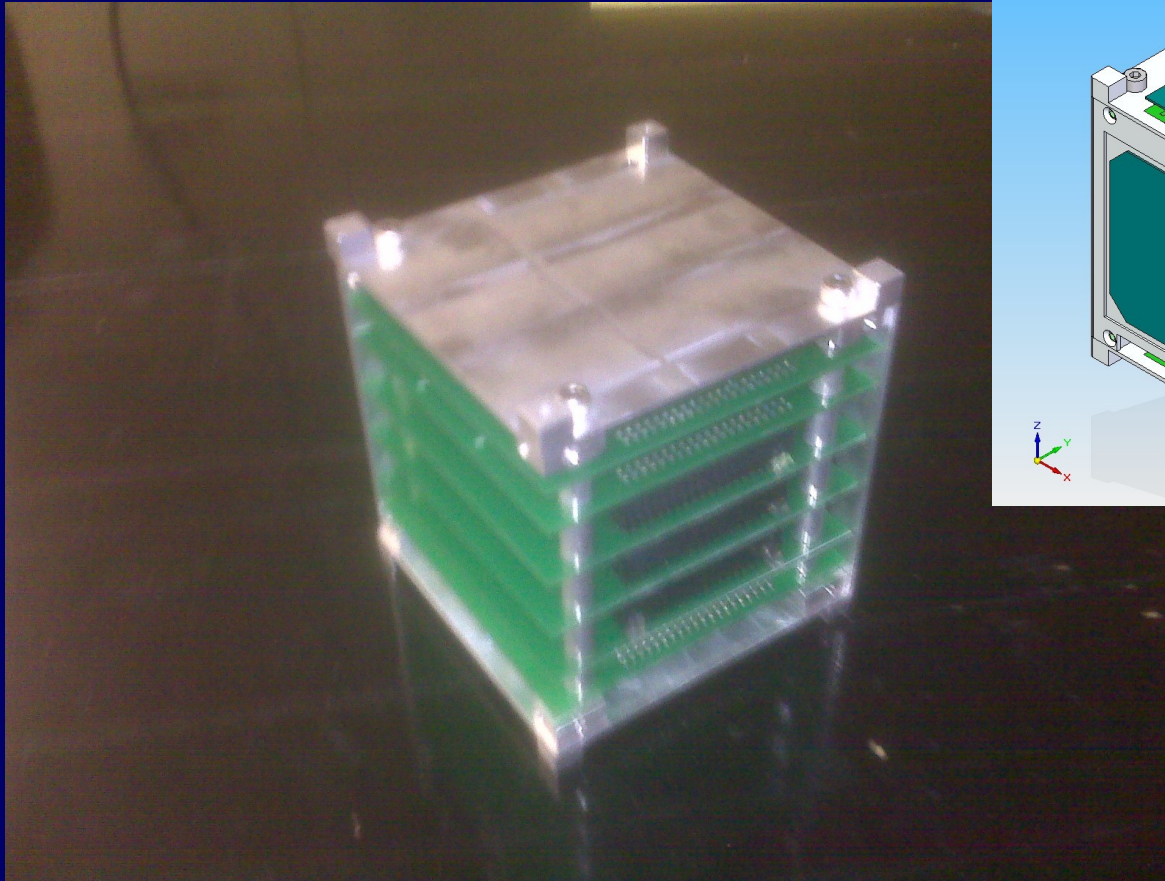
CubeSat

- ***Launch program coordinated by
University of California
Polytechnic Institute, San Luis
Obispo***
 - ***10 cm cube***
 - ***1 kgm mass***
- ***700km altitude polar orbit***
 - ***Low power/data rate***

Aubresat-1: Functional Block Diagram



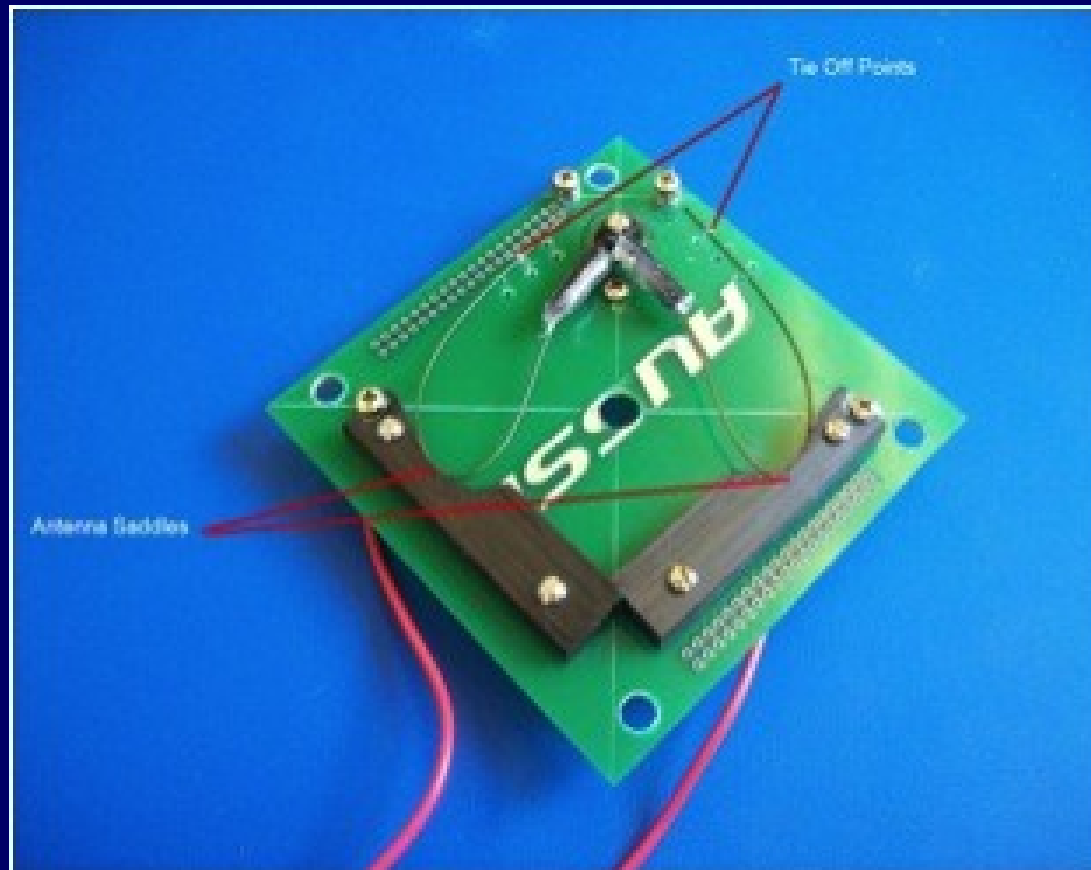
Aubiesat-1: Structure



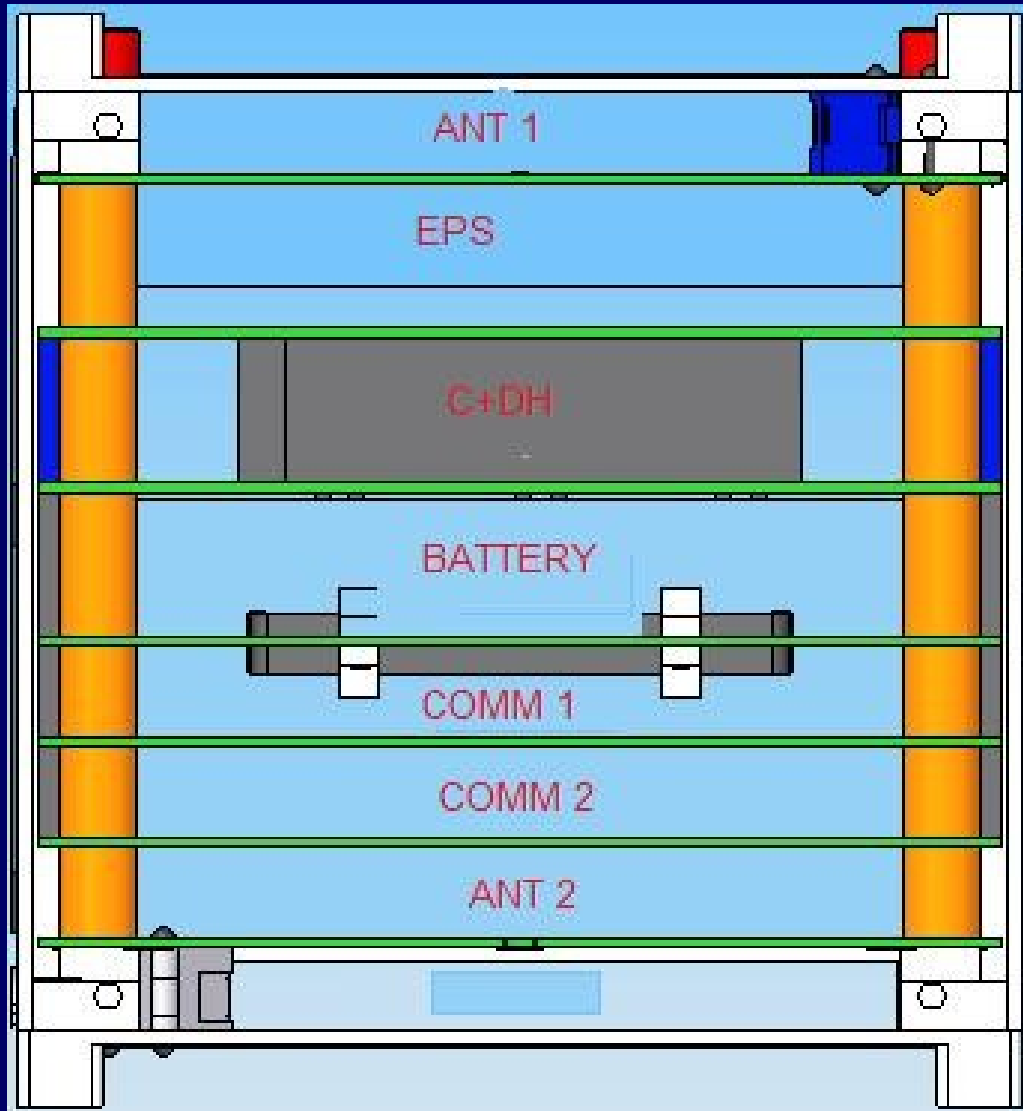
Design Summary

- ***CalPoly Cubesat design compliant***
- ***Stack of circuit boards, connected by headers***
- ***Aluminum frame and end plates***
- ***Covered on all sides by solar panels***
- ***External data / power connector & RBF***
- ***Antennas deployed from corners via “Nichrome wire and fishing line”***

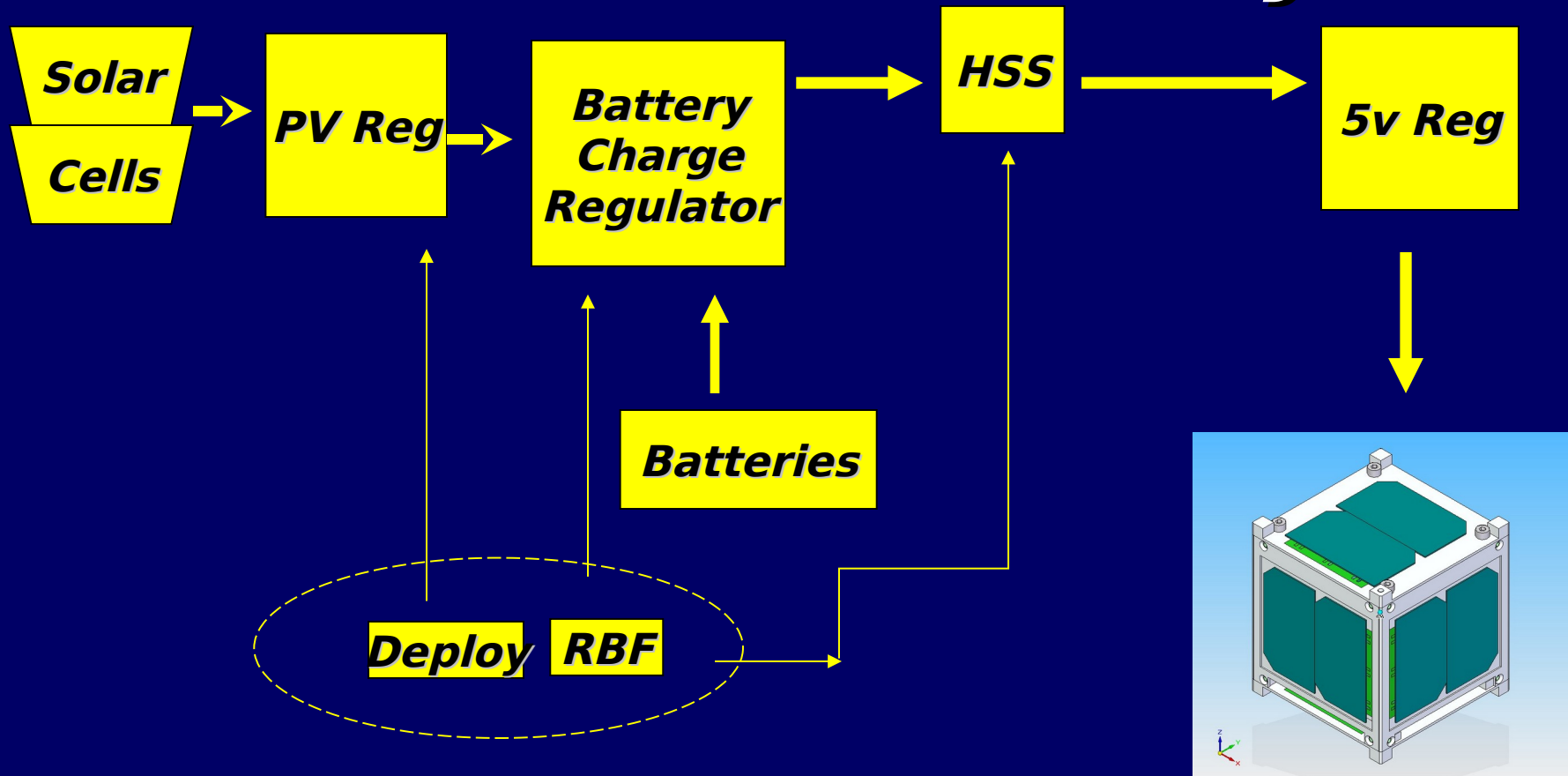
First Prototype Antenna Deployment Mechanism



Structure



Electrical Power System



Electrical Power System

- ***26% Efficiency Solar Cells On Six Sides***
- ***LTC 3533 PV Voltage Regulators***
- ***Max 8677C Battery Charge Regulator***
- ***Dual Li-ion Batteries for Redundancy***
- ***3.7- 4.7V Internal Unregulated Supply***
- ***RBF / Deploy controlled Power Switch***
- ***MAX1709 5V Redundant Converters***
- ***5V Regulated Main Bus***

Comm System

- ***Communication on 70cm, 435-438 MHz***
- ***Primary and Secondary receivers, both based on Melexis TH71102***
- ***Primary RX / TX communicates to ground stations via 1200 baud Direct FSK using AX.25 protocol, Melexis TH72011***
- ***Secondary receiver provides independent, redundant IARU / FCC required positive transmitter control***

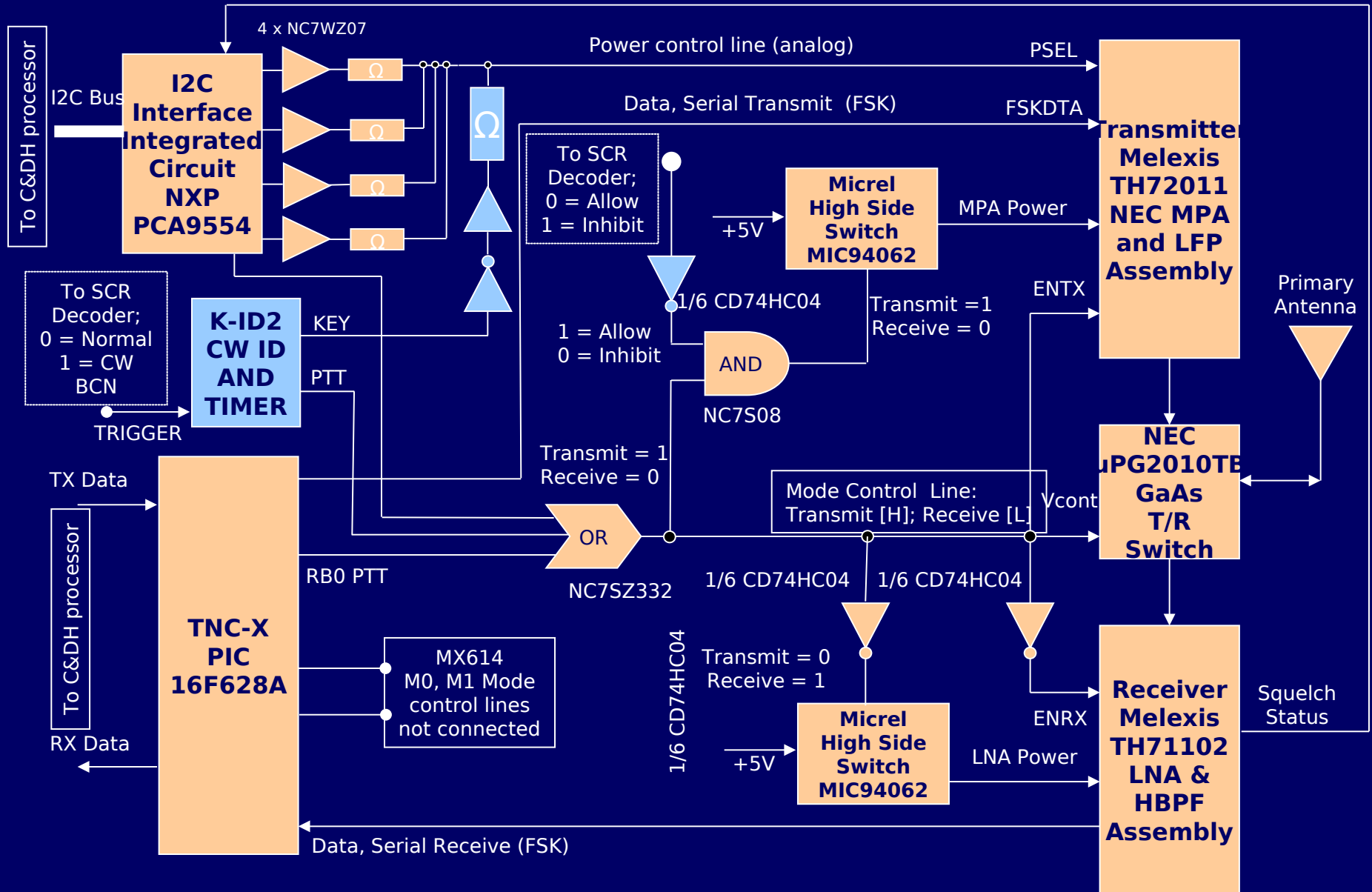
Comm Hardware

- ***Transmitter / Receiver Changed Since Paper Submission For This Conference Away From Handie-talkie***
- ***Primary TX / RX Share An Antenna, Secondary Receiver Has Dedicated Antenna At Diagonally Opposite Corner***
- ***Primary Transmitter Capable Of CW And 1200 Baud FSK Transmissions***
- ***Transmitter Output Power ~ 500 mW***

Types of transmission

- ***Periodic CW Beacon With Call Sign And Critical Data Values (E.G. Regulated Bus Voltage, Total Current Consumption, Temperature)***
- ***Periodic Unnumbered Information Frame (UI) AX.25 Beacon With More Data Values***
- ***Ax.25 Connected Mode Communications Initiated By Ground Station***
- ***Ax.25 UI Command From Ground Station To Be Used When Connection Cannot Be Established***
- ***One-way Control Command From Ground To Secondary Receiver***
- ***Dead Carrier for Polarization Measurements***

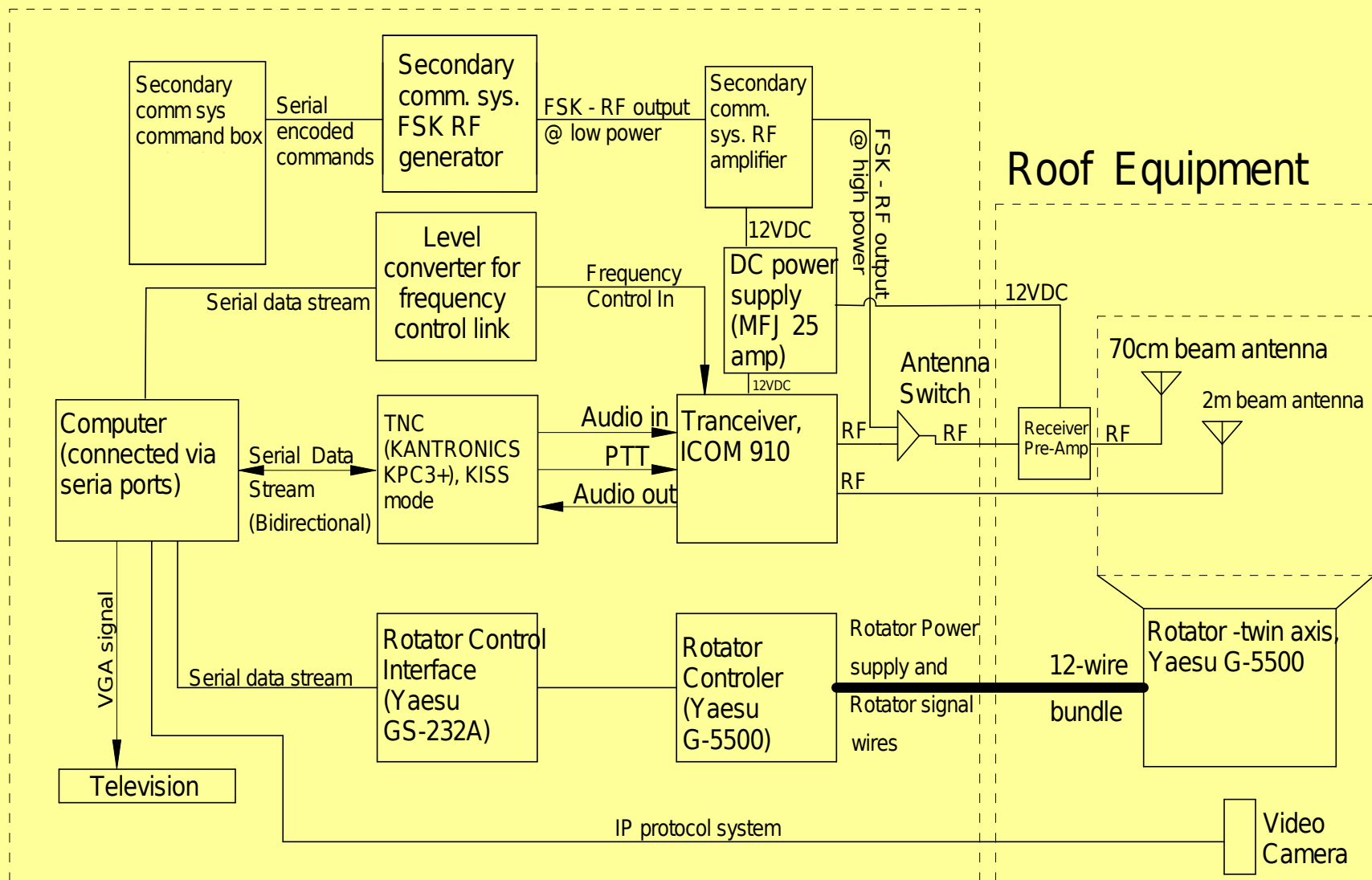
Audacious Transceiver



*The **AU**dacious Transceiver*

A uburn
U niversity
D igital
A ccess
C ommunications
I nterface,
O perational
U HF
S ubsystem

Ground Station Equipment



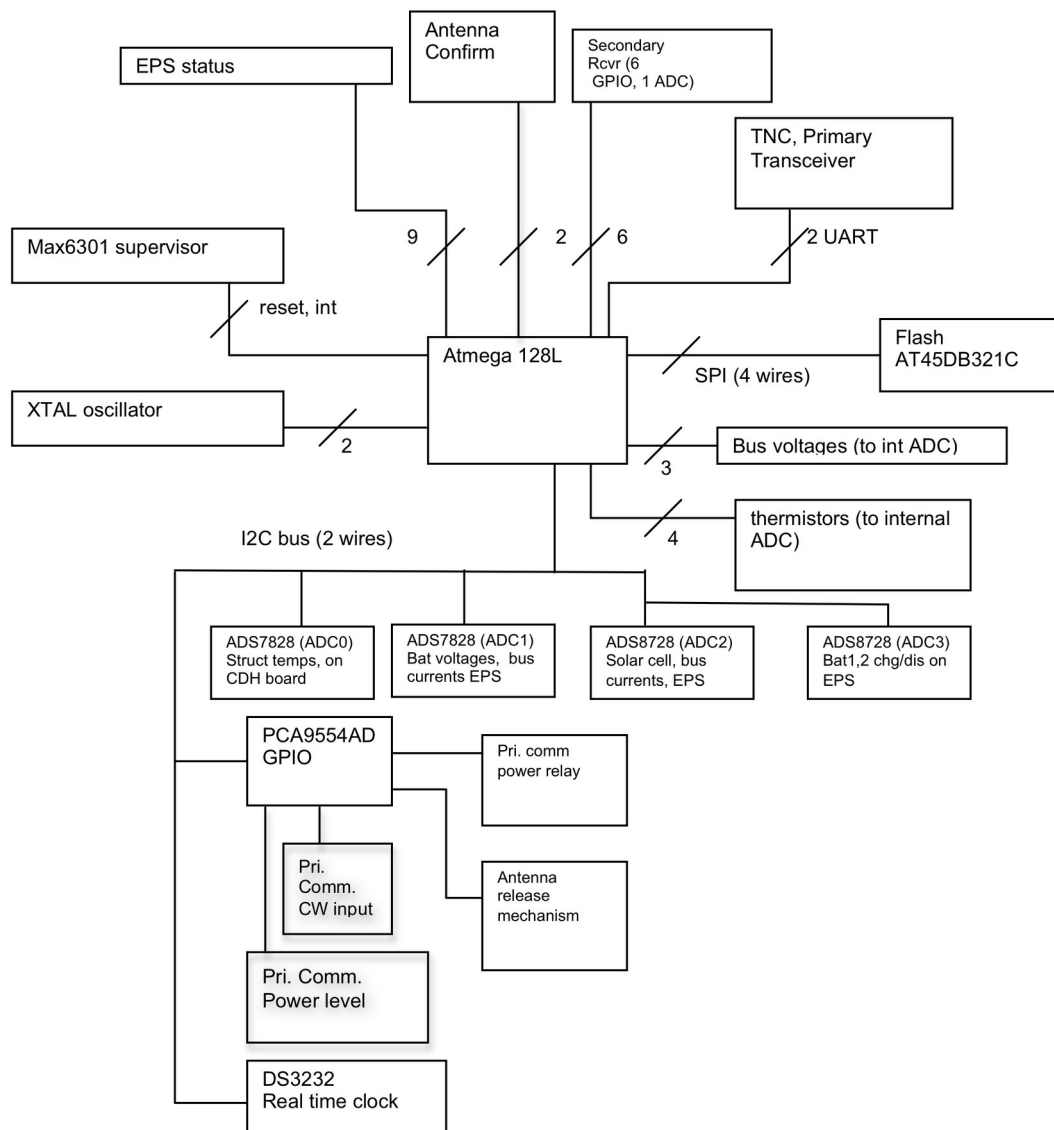
Control and Data Handling

- ***Atmel Atmega 128L μ C; 4 MHz***
- ***External Atmel 32MB data-flash data memory connected via SPI bus***
- ***I²C bus for inter-board communications***
- ***4 8-channel 12-bit ADC chips***
- ***Various I²C GPIO chips for EPS control, antenna deployment, etc.***

- ***Micro C/OS-II Real Time Kernel Is The Basis Of Control Software***
 - ***Cooperative Multitasking***
 - ***Semaphores, Mailboxes, Timers***
- ***Custom AX.25 Stack Drives TNC-X PIC Microcontroller Via Serial Port***
- ***PIC Handles Framing And Error Checking Between C&DH And The Primary Transceiver***
- ***Watchdog Timer & Real-Time Clock***

C & DH Block Diagram

C & DH BLOCK DIAGRAM v2.1
9/12/2008



Program Management

- ***Waterfall-style design model***
- ***Systems engineering duties handled by a grad student in Industrial Engineering with significant aerospace industry experience***
- ***Currently in Preliminary Design Review stage***

Techniques

- ***Weekly stand-up status meetings***
- ***Short-interval scheduling***
- ***Subversion (SVN) version management***
- ***Trac web-based ticket-tracking system***
- ***Undergraduate and graduate student volunteers, engineering senior design students, faculty, and alumni advisors involved in the design and construction of Aubiesat-1***

Anticipated Schedule

- ***PDR - October 2008***
- ***IARU Coordination - November 2008***
- ***CDR - December 2008***
- ***Environmental Testing - Winter 2009***
- ***Shipment to Cal Poly - May 2009***
- ***Launch - 2010 (?)***

Involvement

- ***Welcome assistance from the amateur radio satellite service community***
- ***We will need stations to help us capture polarization correlation data and primary downlink data streams***
- ***We will need several geographically distributed secondary command stations***



War Eagle !